# SEDIMENT MONITORING PLAN:
# DENNY WAY/LAKE UNION
# COMBINED SEWER OVERFLOW PROJECT

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# 1.0 INTRODUCTION

King County Wastewater Treatment Division, in cooperation with the Washington State Departments of Ecology, Natural Resources and the National Marine Fisheries Service, is in the process of developing a monitoring plan for the marine environment at the location of the soon to be constructed Denny Way outfall system. The outfall system will consist of two outfall pipes through which treated and untreated Combined Sewer Overflow (CSO) will be discharged. The first outfall pipe, the 96-inch diameter Elliott West Outfall, will discharge treated CSO flows about 490 feet from shore at a water depth of 60 feet mean lower low water (MLLW). The second outfall pipe, the 120-inch Denny Way CSO outfall extension, will discharge untreated CSO into Elliott Bay. This discharge is about 120 feet long and at a water depth of 20 ft. below MLLW. Currently untreated CSO is discharged into Elliott Bay about 50 times per year; upon completion of this project treated CSO is expected to be discharged into the Bay between 4 and 20 times per year, while untreated CSO events may occur once per year (on average).

This introduction provides a brief site history, describes the area of concern and reviews the historical information. Section 2 describes the monitoring program roles and responsibilities, goals and objectives and an adaptive management strategy to meet those goals and objectives. Section 3 describes the technical approach to be used in the monitoring program. This includes the types of samples to be collected and the monitoring schedule. Section 4describes the general elements associated with the project data management plan.

This document represents a conceptual plan by which King County will monitor the environment surrounding the Denny Way CSO outfalls. Following approval of this conceptual plan King County will prepare a detailed sampling analysis and quality assurance project plan by which the actual work will be carried out.

## 1.1 SITE HISTORY

Outfalls have discharged to Elliott Bay in the vicinity of Denny Way since 1895 when the City of Seattle constructed two sewage outfalls. These outfalls operated (discharging raw sewage) until 1969 when the Elliott Bay interceptor line was installed along the Seattle waterfront and the Denny Way outfall was converted to a CSO. This outfall is the largest CSO discharge in the King County system and large volumes of combined stormwater runoff and sewer overflow are discharged at this location.

Studies beginning in the late 1970's investigated possible environmental effects associated with operation of the historic sewer line and Denny Way CSO. Several investigations documented elevated levels of toxicants in the bottom sediments and associated adverse biological effects (e.g., Tetra Tech 1986, Romberg et al. 1997). In

1986, the King County (then Metro) began a trial program to identify and reduce toxicant inputs to the sewer system discharging through the Denny Way CSO outfall. The Denny Way Sediment Cap was created in 1990 as a demonstration project to remediate contaminated sediments. The cap was a 3-ft thick layer of clean sediment placed over 3 acres of chemically contaminated subtidal sediments offshore of the outfall. In 1997, King County proposed construction of two new outfalls at the Denny Way location.

### 1.1.1 Existing Surface Sediment Data

Sediment data from the cap monitoring program showed that surface sediments in the center of the cap were becoming gradually recontaminated, with the highest concentrations found at the station closest to shore and the existing Denny Way CSO outfall (SEA 1997). Butyl benzyl phthalate and bis(2-ethylhexyl)phthalate are the primary chemicals of concern in cap sediments.

Surface sediments around the cap have higher chemical concentrations than sediment on the cap (SEA 1998). The primary chemicals of concern are total PCBs, bis(2-ethylhexyl)phthalate, butyl benzyl phthalate, and mercury. Exceedances of Washington State Cleanup Screening Levels (CSL) are found in sediments inshore of the sediment cap and just north of the proposed outfall construction area.

### 1.1.2 Existing Subsurface Sediment Data

The vertical extent of chemical contamination is an issue when surface sediments are removed and subsurface sediments are exposed. Detected chemicals in subsurface sediments include bis(2-ethylhexyl) phthalate, butyl benzyl phthalate, silver, total PCBs, mercury, and PAH compounds. Both the highest frequency of chemical exceedances and the greatest magnitude of exceedance occur inshore of the sediment cap. The vertical extent of chemical contamination is variable, but extends up to 6 - 8 ft deep in some areas.

## 1.2 AREAS OF CONCERN

Five areas of concern requiring remediation have been identified (SEA 1999). Two of these areas are located inshore of the 1990 sediment cap and the three remaining areas are located offshore of the sediment cap. Dredging and disposal of contaminated sediments following outfall construction was identified as the preferred remedial alternative for the inshore areas of concern. Containment by thin-layer capping was the preferred alternative for the offshore areas.

# 2.0 MONITORING PROGRAM ORGANIZATION

## 2.1 ORGANIZATIONAL ROLES AND RESPONSIBILITIES

The monitoring program will be managed and implemented by King County Department of Natural Resources. The proposed monitoring plan will be reviewed by state and federal agencies to insure compliance with environmental laws and regulations. The agencies and their regulatory roles include:

- National Marine Fisheries Service for endangered species issues
- U.S. Fish and Wildlife Service for endangered species issues
- The U.S. Environmental Protection Agency for NPDES monitoring requirements
- Washington State Department of Natural Resources as the Trustee of Washington State submerged lands
- Washington State Department of Ecology for issues relating to the state sediment management standards and for NPDES monitoring requirements.

## 2.2 ENVIRONMENTAL GOALS AND OBJECTIVES

The primary goal of the Denny Way Monitoring Program is to produce scientific data of known quality that can be used to determine whether the implementation of the Denny Way/Lake Union CSO Control Project has led to a reduction in the risk to human health and to the biological communities in the marine environment surrounding the CSO. If the operation of the outfalls causes increased contamination of marine sediments in the surrounding area to a level which exceeds an established criteria, this monitoring program will lead to a cleanup of the contamination.

this monitoring would identify such contamination and help King County and the other interested agencies develop a response plan.

### 2.2.1 Monitoring Objectives

The objectives necessary to meet the program goal include the following:

- Determine the extent of chemicals of concern in the vicinity of the Denny Way CSO
- Determine the condition of the benthic and epibenthic communities in the area surrounding the Denny Way CSO through the use of:
    - Sediment Profile Imaging (SPI)
    - Video transects

Each of these objectives will be supported by the monitoring program elements as described in Section 3.

### 2.2.2 Sediment Quality Criteria

Sediment quality screening values have been developed out of the need to determine whether chemicals in sediments are causing harm to biological communities. The Washington State Sediment Management Standards (SMS), which are based on the apparent effects threshold approach, were adopted for use in Puget Sound in 1991 and revised in 1995 (Chapter 173-204 WAC). The SMS guidelines (and future revisions) will be the primary sediment quality criteria used in the Denny Way monitoring program to identify sediments that may be causing harm to the resident biological community.

As a secondary measure of effect, sediment chemistry data will also be compared to sediment quality guidelines based on the effects range approach. This approach was developed by Long and Morgan as a more sensitive tool for assessing the effects of single chemicals on biological populations (Long and Morgan 1990). The effects range-low value (ER-L) and effects range-median value (ER-M) represent the $10^{th}$ and $50^{th}$ percentile value respectively, for a range of chemical concentrations at which biological effects are expected to occur. For regulatory purposes the SMS will remain the prime determinant of biological effects for the monitoring program.

There are numerous other methods for developing sediment quality guidelines and as new and more promising methods appear they will be evaluated for use in the Denny Way Monitoring Program.

## 2.3 ADAPTIVE MANAGEMENT STRATEGY

The National Research Council in 1989-1990 formed a committee to review the role of marine environmental monitoring as a management tool in pollution abatement programs across the nation. The committee determined that a primary factor in designing and implementing a successful monitoring program was to maintain flexibility in the design. This includes refining the program goals and objectives as part of the monitoring program evaluation process. This flexibility forms the core of the adaptive management strategy approach used in this monitoring program.

The adaptive management strategy will focus on the following elements:

- With the aid of the regulatory agencies, finalize clearly defined objectives with the ultimate goal of adapting and modifying the monitoring program as necessary based on the results to date
- Support a tiered sampling and analysis design that will allow the collection of sufficient data to clearly characterize conditions in the area surrounding the site

- Provide flexibility to re-evaluate the objectives of the monitoring program to reflect changing site conditions or new listings under ESA
- Provide flexibility to re-evaluate monitoring requirements if applicable standards, guidelines and analytical techniques are developed in the future.

The framework described above will include an extensive pre-construction baseline survey to document the condition of the existing biological community. The biological and chemical data to be obtained, as part of the pre-construction monitoring will be reviewed in conjunction with the 1998 Denny Way sediment characterization study to determine if conditions in the program area have changed over time. This will enable the monitoring program to clearly differentiate between construction-related effects and effects due to past chemical contamination. Following construction of the outfall system, a second round of sampling will occur to establish post-construction baseline conditions. After baseline conditions are established, a scaled down monitoring event will occur on an annual basis for the first five years following construction. A description of each round of sampling, the parameters to be measured, and the location of sampling stations can be found in Section 3.

This plan does not include the use of toxicological, bioaccumulation testing and benthic community analysis as routine measures for accessing sediment impacts. In discussions with the NMFS they indicated that they lacked confidence in the ability of these tests to detect true statistically significant differences between test and reference stations. These tests may be reintroduced into the monitoring program in the future should test and analytical methods improve so that differences between test and reference stations can be better quantified.

As part of the adaptive management strategy King County, on a case by case basis will consider conducting biological tests in the event that chemical criteria are exceeded. The toxicological tests may then be used to examine the extent of the sediment toxicity and the benthic community data can be compared to the pre-and post-construction benthic community data to determine whether conditions have changed over time. The data from the biological tests are not intended to overturn the results of the chemical analyses but to complement them by quantifying the level of potential effect.

Sediment remediation projects are proposed for the project vicinity, including the remediation of Areas A and B, identified in the Sediment Remediation Plan, dated May 1999. It is likely that sediment monitoring will occur following implementation of the remediation projects. Such monitoring will be coordinated with this monitoring plan, to avoid duplication of efforts. In addition, it may be necessary to re-establish “baseline” conditions after completion of the remediation projects. This will be accomplished through the adaptive management strategy described above.

## 2.4 EVALUATION OF MONITORING RESULTS

As discussed above, the monitoring results will be compared to the State Sediment Standards and to other relevant standards and guidelines that are in effect at the time the sampling data are collected. In the event that the sampling results show that standards are being exceeded, King County will take the following steps:

- Identify the contaminant that exceeds the standard or guideline
- Identify the geographic extent of the exceedance
- Develop a sampling plan to collect additional data to confirm the exceedance and the geographic extent of it
- Develop a methodology to compare data from the Denny CSO area to control areas, as discussed further below.
- Use the original and additional data to determine the likelihood that the exceedance is being caused by the Denny Way/Lake Union CSO Control Project outfalls.
- If the source of the contamination is not identifiable additional sampling and analysis of sediment will be conducted and the results will be correlated to the contaminants in the discharges to determine the source
- As appropriate, in conjunction with other agencies with jurisdiction, develop a remediation plan to address the identified area of contamination

King County is committed to addressing contamination of sediments in the project vicinity, should they become contaminated due to operation of the project outfalls. Methods to address such contamination, should it occur, could include, but are not limited to, 1) removal of the contaminated material, disposal at an approved site, and replacement with clean material, or 2) thin- or thick-layer capping. 3) evaluate the use of new technology which may be developed in the future to remediate contaminated sediments. Depending on the nature of the contamination, King County may also consideration modifications to the operation of the CSO project to reduce discharge of the contaminants of concern.

## 2.5 EVALUATION OF THE MONITORING PROGRAM

A periodic re-evaluation of the monitoring program will occur following a review of results from each round of sampling. This necessary step in the adaptive management strategy approach will ensure that management decisions are based on scientifically defensible information that points out progress in meeting the objectives of the monitoring program. Among other things, this re-evaluation will address the need for conducting biological testing and discuss the need for monitoring beyond the 20-year time frame outlined in this plan.

# 3.0 TECHNICAL APPROACH

## 3.1 PROGRAM DESIGN

The experimental design of the monitoring program is an integrated effort that includes the use of Sediment Profile Imaging (SPI), video surveys of the nearshore and subtidal habitats, and the sampling of sediment to characterize the chemical elements in the program area.

### 3.1.1 Sample Types

3.1.1.1 Sediment Profile Imaging

The SPI system consists of a camera mounted in a wedge shaped stainless steel housing. The system is lowered to the sea floor from a sampling vessel and the camera takes a photographic image of the sediment water interface. SPI obtains photographs, in profile, of the top 10 to 30 centimeters of the sediment column. From these photographs, geological, biological, and geochemical features can be discerned, measured, and mapped. These parameters include:

- Sediment grain size: up to 4 phi (Sand/Silt)
- Redox Potential Discontinuity (RPD): Represents the depth to which oxygen diffuses into sediment
- Gas Voids: Generally indicates the presence of methane and/or hydrogen sulfide ($H_2S$) in organic rich sediments
- Benthic community successional stage
    - Stage 1 Community: Characterized by small short-lived species that are rapid reproducers. Examples are capitellid and dorvilleid polychaetes
    - Stage 2 Community: Broad mix of species with characteristics of Stage 1 and 3 species. They begin colonizing sediment when $H_2S$ dissipates. Examples include the bivalves *Parvilucina* spp. and *Axinopsida serricata*
    - Stage 3 Community: These species tend to be large, relatively long lived, and burrow deep in the sediment often feeding in a head down position. Examples include maldanid polychaetes and the holothuroid *Molpadia* spp.

SPI is used to monitor conditions and delimit the distribution of disposed sediments at unconfined dredged material disposal sites, in-place capping areas, and confined aquatic disposal sites, often in conjunction with acoustic methods. SPI is also used to map benthic conditions in areas affected by contamination, organic loading, and natural or anthropogenic disturbances. It has proven to be an effective benthic reconnaissance tool to help cost-effectively direct follow-on chemical and biological sampling.

In the first five years the Denny Way Monitoring Program, the role of SPI will be as a screening tool to determine the geological, biological, and geochemical condition of sediment in the monitoring area. This will allow a determination, in near real time, of whether conditions have changed since the previous monitoring event.

#### 3.1.1.2 Video Surveys

Video surveys of the program area will be conducted to confirm or deny the presence of eel grass and kelp beds. The video survey equipment will also be attached to the SPI camera frame and the two systems will be used in concert to characterize the epibenthic community and to identify the large macroinvertebrates inhabiting the monitoring program area.

#### 3.1.1.3 Sediment Chemistry

Sediment samples from the upper 2 cm of the sediment surface will be collected for chemical analysis. Sixty-six chemical compounds representing 10 heavy metals, 4 volatile, 37 semivolatile organic compounds and PCBs and pesticides will be analyzed These chemical compounds include those found on the SMS and the Puget Sound Dredged Disposal Analysis (PSDDA) analyte lists and their methods of analysis (Table 1).

#### 3.1.1.4 Quality Assurance Plan for Sediment Chemistry

The quality assurance program will be based on EPA guidance for the development of management and quality assurance prioject plans (EPA 1994, 1997, and 1998b) The analytical chemistry QA manager will coordinate and supervise review of original data packages. The raw data will be examined by experienced data validators to ensure that the calculations and transcriptions from the original data to the data package forms have been correctly conducted. EPA functional guidelines will be used as guidance for the process of data validation (EPA 1988b&c); the CLP IFB/SOW-specified QC criteria, when available, will be used for determination of compliance with QC objectives; and the PSDDA data qualifier codes/descriptors will be applied for consistency with Puget Sound programs.

### 3.1.2 Sampling Locations

#### 3.1.2.1 Monitoring Program Stations

Thirty-two stations have been selected for SPI monitoring. Sixteen of these stations will be collocated at stations intended for chemical analysis (Figure 1).

Six video transects will be established running parallel to the Myrtle Edwards Park shoreline (Figure 1). In addition the video system will be mounted on the SPI camera

frame so that organisms captured by the SPI camera will also be seen in plane view. This will greatly enhance the ability to characterize the epibenthic community.

The sediment sampling locations are presented in Figure 1 and their coordinates are listed in Table 2. Sixteen sediment stations are arranged around the CSO in a grid pattern consisting of transect lines running perpendicular to the shoreline. The two outer most transect lines consists of four stations, followed by two additional transects consisting of three stations each. The final two stations are located off of the mouth of the 490-foot Elliott West outfall. A grid design was selected over a radial design because stations arranged in grid pattern designs tend to be more effective at differentiating small-scale changes in the distribution of chemical contaminants (Bascom 1982).

Sediment samples for chemical analysis will be collected from 16 locations. Fourteen of these sampling locations will be at stations originally sampled as part of the Denny Way Sediment Characterization (SEA 1998). This will allow continuity with past studies and greatly enhance the database for the monitoring program.

## 3.2 MONITORING SCHEDULE

### 3.2.1 Monitoring Events

#### 3.2.1.1 Pre-Construction Monitoring

The pre-construction monitoring event should be scheduled in February/March 2001. The elements to be monitored during that event include the following:

- Sediment profile imaging
- Video surveys
- Sediment chemistry
- Benthic community analysis

#### 3.2.1.2 Post-Construction Year 1 Monitoring

The Year 1 monitoring event should occur in the late winter or early spring of the first year following construction of the outfall system. The elements to be monitored during that event include the following:

- Sediment profile imaging
- Video Surveys
- Sediment chemistry
- Benthic Community Analysis

The current project schedule shows completion of the outfall construction in mid-2002. Therefore, it is likely that the Year 1 monitoring would occur in 2003. The purpose of this monitoring would be to determine construction impacts.

Operation of the new outfalls will not occur until other project facilities are completed and final connections can be made. Operational testing of the facilities is scheduled to begin in 2003. Routine operations will begin in mid-2004. Therefore, Year 2 monitoring would be expected to occur in 2005.

#### 3.2.1.3 Year 2 Monitoring

The Year 2 monitoring of the outfall system should occur in the late winter or early spring of the year 2005. The purpose of monitoring in Years 2 and beyond is to identify impacts of project operation in the six months prior to sampling the monitoring program will be reviewed in light of the program's adaptive management strategy. At this time the analysis of sediment for bioaccumulation potential may be dropped from the monitoring program. The elements to be monitored during Year 2 include:

- Sediment profile imaging
- Video surveys
- Sediment chemistry

#### 3.2.1.4 Year 3 Monitoring

The Year 3 monitoring of the outfall system should occur in the late winter or early spring of the year 2006. In the six months prior to sampling the monitoring program will be reviewed in light of the program's adaptive management strategy. The elements to be monitored during Year 3 include:

- Sediment profile imaging
- Video surveys
- Sediment chemistry

#### 3.2.1.5 Year 4 Monitoring

The Year 4 monitoring of the outfall system should occur in the late winter or early spring of the year 2007. At this point, three years of intensive monitoring will have occurred at the outfall system. In the six months prior to the Year 4 sampling the monitoring program will be reviewed in light of the programs adaptive management strategy. The elements to be monitored during Year 4 include:

- Sediment profile imaging
- Sediment chemistry

- Video surveys

3.2.1.6 Year 5 Monitoring

The Year 5 monitoring of the outfall system should occur in the late winter or early spring of the year 2008. In the six months prior to the Year 5 sampling the monitoring program will be reviewed in light of the program's adaptive management strategy. Sufficient synoptic data will have been collected using the SPI/Video system to drop the video from further monitoring events. The elements to be monitored during Year 5 include:

- Sediment profile imaging
- Sediment chemistry

3.2.1.7 Year 10 Monitoring

The Year 10 monitoring of the outfall system should occur in the late winter or early spring. The elements to be monitored during Year 10 include:

- Sediment profile imaging
- Sediment chemistry

A review of data from the Year 10 monitoring event will determine whether sediment conditions in the monitoring area have changed since the previous full monitoring event in Year 5. If conditions have improved or remained static, then the monitoring events in Years 11 to 14 will proceed as in Years 6 to 9.

3.2.1.8 Year 15 Monitoring

The Year 15 monitoring of the outfall system should occur in the late winter or early spring. The elements to be monitored during Year 15 include:

- Sediment profile imaging
- Sediment chemistry

A review of data from the Year 10 monitoring event will determine whether sediment conditions in monitoring area have changed since the previous full monitoring event in Year 10. If conditions have improved or remained static, then the monitoring events in Years 16 to 19 will proceed as in Years 11 to 14.

### 3.2.1.9 Year 20 Monitoring

The Year 20 monitoring of the outfall system should occur in the late winter or early spring. The elements to be monitored during Year 20 include:

- Sediment profile imaging
- Sediment chemistry

A review of data from the Year 20 monitoring event will determine whether sediment conditions in monitoring area have changed significantly since the previous full monitoring event in Year 15.

In addition, these data will be reviewed to determine the level of monitoring that would continue to occur throughout the remaining life of the project. At this time, King County would propose that monitoring occur every 10 years, using the same monitoring scheme as outlined above. However, the actual frequency of monitoring will be determined in conjunction with the interested agencies based on consideration of the 20-year sampling results.

If the sediments from any station show a chemical contaminant increasing in concentration over time, then the sediments at that station will be sampled until the there is no further increase. If the concentration reaches a level that exceeds the sediment management standards then remedial action may be necessary. This action could include sediment removal and treatment, or capping in conjunction with some form of pretreatment to remove the chemical or reduce its concentration in the effluent stream.

# 4.0 DATA MANAGEMENT

The primary purpose of data management is to provide data of known quality that are complete, accurate, consistent, and organized in a usable format. Data management procedures will include a standardized system for storing, adding, processing, analyzing, retrieving, and reporting information. Prior to the initiation of field sampling, the analytical and biological laboratories will be asked to supply their data in an electronic format that will load directly into the database.

All field, chemical and biological data will be reviewed and validated to ensure quality. Chemical data review will include, at minimum, assessment of precision, accuracy, representativeness, comparability and completeness. Data qualifiers and usability flags will be applied, as necessary.

Data will be analyzed using standardized analysis methodologies, such as statistical comparisons of values to reference conditions or regulatory standards. Standardized data reporting products will be developed that clearly indicate the results and sources of the data. The data will also be input into a GIS format for mapping the resulting information for visual examination. GIS may also be used to plot data that are not easily stored in a database format (i.e., SPI and video survey data).

# 5.0 REPORTING

Following each round of sampling a data report will be prepared in accordance with the monitoring plan. The report shall include tabulated physical, chemical, SPI, and biological data, as appropriate for the monitoring event. It will also include a summary of field activities, field methods, and data validation. Numerical results will be compared to appropriate regulatory criteria or screening levels. The pre- and post-construction surveys will also include an analysis and discussion of the benthic invertebrate community found in the study area.

The report shall be distributed in a timely manner to the following resource agencies:

- National Marine Fisheries Service
- U.S. Fish and Wildlife Service
- The U.S. Environmental Protection Agency
- Washington State Department of Natural Resources
- Washington State Department of Ecology

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